FOUNDRY AND PLANT LAYOUT METHOD FOR IT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a foundry and a plant layout method for the foundry, and more particularly to: a foundry plant for efficiently making a casting by using a sand mold of the self-hardening type, where the foundry plant has the optimum layout of its equipments to facilitate any kind of transfer operations of articles such as metal flasks, main patterns, core patterns and/or any jigs used in this connection in the plant; and, a plant layout method for the foundry having such optimum plant layout.

2. Description of the Related Art

In a conventional foundry plant in which a self-hardening mold for making a casting (i.e., cast article) is used, there has been provided an outdoor storage area, stored in which are various types of metal flasks. Also having been provided in the conventional foundry plant is a building wherein main patters, core patters and like articles are stored. In making a casting in accordance with a production instruction in the conventional foundry plant, desired ones of the articles such as the metal flasks, main patters and the core patters are first brought into the foundry plant from their individual storage areas by using a suitable transfer means, for example such as various kinds of motor trucks, forklift trucks, overhead cranes and like facilities. Of these desired ones thus brought into the foundry plant, a main pattern is set in a metal flask. After that, a sand of a self-hardening type, which has been mixed, kneaded in a mixer and thus prepared, is filled in such a metal flask to permit the filled sand to be hardened in the metal

flask. After completion of hardening of the sand which has been filled in the metal flask together with the main pattern, the mold/metal flask assembly is pulled up using the overhead crane, and then subjected sequentially to a pattern drawing operation, a mold coating operation and to a mold drying operation. The main core is then set in the thus dried mold. After that, a mold mating or coupling operation of a cope half and a drag half of the mold is performed to prepare a completed mold. A plurality of the completed molds thus prepared are then transferred to a molten metal pouring area, where the molten metal (hereinafter referred to simply as the "melt") is poured into the completed molds.

As for the core, such a core is prepared in another place other than the conventional foundry plant. Consequently, the core must be first brought into the foundry plant. In the plant, the core is hardened. After completion of such hardening of the core, the core is subjected to a coating and a drying operation, and then set in the main mold, so that a mold assembly including the core is completed. Such a mold assembly after completion of the melt pouring operation is subjected to a natural or room-temperature cooling operation as it is poured with the melt, to effect the hardening of a casting melt in the mold assembly. After completion of cooling of the casting, the mold assembly is then transferred to a flask disassembling area.

In this flask disassembling area, the mold assembly is disassembled into the casting, its metal flask, and its casting sand by a foundry worker using the overhead crane provided in the conventional foundry plant. The casting thus disassembled from the mold assembly is then subjected sequentially to an appropriate surface treatment such as a shot blasting and like surface treatments,

a finishing working and an inspection to become a final casting product to be shipped.

On the other hand, the remaining disassembled or used parts such as the metal flask, main pattern and the core pattern of the mold assembly are returned to their predetermined areas by means of the motor trucks, forklift trucks, overhead cranes and like facilities used in the conventional foundry plant. As for the casting sand, such a sand is subjected to a reclaiming treatment and then returned to the mixer.

The above-mentioned conventional method is very poor in production efficiency due to the presence of a large number of complicated production steps, which are required in transferring various types of articles between individual processes steps which are required in the conventional foundry plant. Consequently, the conventional method in production system requires a large amount of working area together with a large number of article transferring steps. Due to this, the worker's production efficiency in the conventional method only reaches a value of approximately 3-8 ton/man. In other words, the working area's production efficiency (i.e., cost-to-floor area productivity) per month in the conventional method only reaches a value of approximately 50 Kg/m^2, provided that the working area includes a storage area for each of the metal flask and the patterns. Since the foundry plant according to the conventional method requires a large amount of working area, dust and fumes generated in the plant tend to be dispersed through the entire plant, which seriously impairs the entire plant in working environment. This is another problem inherent in the foundry plant according to the conventional method.

SUMMARY OF THE INVENTION

Under such circumstances, the present invention was made to solve the problems inherent in the prior art. Consequently, it is an object of the present invention to provide a foundry plant and a plant layout method for the foundry, where the foundry plant has: its complicated article transfer steps remarkably simplified in construction; a transfer distance of each of articles such as jigs and other members between the article transfer steps remarkably reduced; and, its article transfer system be substantially free from any use of an overhead cranes and like facilities installed in a conventional foundry plant, so that: a plurality of storage/supply areas for storing and supplying various kinds of materials, molds, jigs and like articles are directly connected with a plurality of working areas for making the mold, melting the metal, pouring the melt, disassembling the flask from the mold and for performing like operations, thereby remarkably improving the foundry plant of the present invention in both the worker's production efficiency and the working area's production efficiency per month in the plant.

In accordance with a first aspect of the present invention, the above object of the present invention is accomplished by providing:

A plant layout method for a foundry comprising the steps of:

arranging a multi-story warehouse (1) in a central portion of the plant, the warehouse (1) being provided with a stacker crane (4, 4a) and a plurality of storage portions (4, 5, 6, 7, 45) for storing therein a core pattern, a core, an empty one of completed molds before subjected to a melt pouring operation and a filled one of the completed mold after subjected to the melt pouring

operation;

arranging a mold making area (10) so as to extend along one of opposite outer sides of the multi-story warehouse (1), where a completed mold is prepared; and

arranging a casting processing area (11) so as to extend along the other of the opposite outer sides of the multi-story warehouse (1) thereby performing in the casting processing area (11) a metal melting operation to prepare a melt, a melt pouring operation for pouring the melt into the completed mold, a cooling operation for cooling the completed mold filled with the melt, a flask disassembling operation for disassembling the completed mold to obtain a casting therefrom, and a surface treating and a cleaning operation of the casting.

In the plant layout method of the present invention described above for the foundry, preferably at least one of the mold making area (10) and the casting processing area (11) has a two-story construction to provide a lower and an upper floor portion, the upper floor portion being formed into an area for making a main pattern, a core pattern and a core.

Further, preferably the lower floor portion is formed into a plurality of areas for: storing therein a metal flask; making a main mold pattern; setting the core; and, mating a cope and a drag half of the mold.

In accordance with a second aspect of the present invention, the above object of the present invention is accomplished by providing:

A foundry plant comprising:

a multi-story warehouse (1) arranged in a central portion of the plant, the warehouse (1) being provided with a stacker crane

(4, 4a) and a plurality of storage portions (4, 5, 6, 7, 45) for storing therein a core pattern, a core, an empty one of completed molds before subjected to a melt pouring operation and a filled one of the completed molds after subjected to the melt pouring operation;

a mold making area (10) extending along one of opposite outer sides of the multi-story warehouse (1), where a completed mold is prepared; and

a casting processing area (11), which extends along the other of the opposite outer sides of the multi-story warehouse (1) to perform a metal melting operation to prepare a melt, a melt pouring operation for pouring the melt into the completed mold, a cooling operation for cooling the completed mold filled with the melt, a flask disassembling operation for disassembling the completed mold to obtain a casting therefrom, and a surface treating and a cleaning operation of the casting.

In the foundry of the present invention described above, preferably at least one of the mold making area (10) and the casting processing area (11) has a two-story construction to provide a lower and an upper floor portion, the upper floor portion being formed into an area for making a main pattern, a core pattern and a core.

Further, preferably the lower floor portion is formed into a plurality of areas for: storing therein a metal flask; making a main mold pattern; setting the core; and, mating a cope and a drag half of the mold.

Still further, preferably at least one of the mold making area and the casting process area has a two-story construction, where: the upper floor portion of the construction is for preparation of the main patterns, the core patters and the cores. This makes it

possible to take any one the main patterns, the core patterns and the cores, all of which have been disposed on the transfer pallets, directly in and out of the upper floor portion of the multi-story warehouse.

Consequently, the present invention has the following effect. Namely, in the present invention, the multi-story warehouse for storing therein all the maim patterns, the core patters and the cores is arranged or incorporated in the central portion of the foundry plant, so that all the mold making area, the core making area, the main pattern and the core pattern making/maintenance area, the melting area, the pouring area, the cooling area for cooling the casting (i.e., cast workpiece) in the mold, and the metal flask disassembling area are arranged in the periphery of the central portion of the foundry plant. Due to such arrangement or layout, the foundry plant of the present invention can be totally mechanized. More particularly, it is possible for the method of the present invention to remarkably improve the thus totally mechanized foundry plant of the present invention in productivity as one of most improved self-hardening mold casting production factory. The foundry plant of the present invention is capable of improving its production efficiency also in a small "heat (i.e., small batch)" of the cast workpiece when the volume of production is relatively low and there are wide variety in material of the workpieces to be cast. This makes it possible to improve the foundry plant of the present invention in cost-to-floor area productivity, which leads to a remarkable cost reduction. Further, in the foundry plant of the present invention, since the casing process area is separated from the mold making area and the like, it is possible to improve the foundry plant in working environment throughout the entire plant.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, advantages and features of the present invention will be more apparent from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a plan view of an embodiment (in the ground floor portion) of the plant layout of the foundry according to the method of the present invention;

Fig. 2 is a plan view of an embodiment (in a second or upper floor portion) of the plant layout of the foundry according to the method of the present invention; and

Fig. 3 is a side view of the plant layout of the foundry according to the method of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The best modes for carrying out the present invention will be described in detail using embodiments of the present invention with reference to the accompanying drawings.

Figs. 1 to 3 show embodiments of a plant layout of a foundry according to a plant layout method of the present invention for the foundry plant. In each of the embodiments shown in the drawings, a part of the foundry plant has a two-story construction, a first or lower floor portion of which is shown in Fig. 1 in plan view. On the other hand, shown in Fig. 2 is a side view of a second or upper floor portion 44 of the foundry plant. Incidentally, in this foundry plant, any production instruction is controlled by a computer-aided production management system of the foundry plant.

In the plant layout method of the present invention for the

foundry plant, a multi-story warehouse 1 is essentially arranged in a central portion of the foundry plant. As is clear from Fig. 1, the multi-story warehouse 1 is constructed of: a pair of storage shelves 2, 3, which extend in parallel to each other vertically (see Fig. 3) and horizontally (see Fig. 1) to form a plurality of storage portions of the foundry plant; and, a pair of stacker cranes 4 and 4a, which travel vertically and horizontally along the storage shelves 2 and 3, respectively, to load and unload a desired article or mold or the like into and out of the storage shelves 2, 3.

Stored in each storage portion of the storage shelves 2, 3 is any one of articles such as jigs, molds and like articles. Allocation of these storage portions of the shelves 2, 3 is properly conducted depending on the types of the articles to be stored therein. In general, a heavyweight one of the articles such as an empty completed mold and a completed mold having been already filled with the melt is loaded into a lower one of the storage portions in the storage shelves 2, 3. In contrast with this, a lightweight one of the articles such as a main pattern, a core pattern and a core is loaded into an upper one of the storage portions in the storage shelves 2, 3. Due to this, the stacker crane 4 installed between the storage shelves 2 and 3 is used for transferring the lightweight articles. In contrast with this, the other stacker crane 4a installed outside the storage shelf 3 is used for transferring the heavyweight articles.

In the foundry plant shown in the drawings, all the storage portions of the storage shelf 2 plus an upper storage portions of the remaining storage shelf 3 are used for storing therein the lightweight articles such as the main patterns, the core patterns, the cores and the like. In contrast with this, the lower or completed

mold storage portion 7 of the storage shelf 3 is used for storing therein a heavyweight article such as the completed main mold regardless of the presence or absence of the melt filled therein.

All the main patterns, core patterns, cores, completed main molds and like articles are stored in the storage portions of the storage shelves 2, 3 in a condition in which these articles are mounted on their dedicated transfer pallets. In this condition, these articles are transferred together with their dedicated pallets.

As shown in Fig. 3, a mold making area 10 is arranged outside the other storage shelf 2. On the other hand, a casting process area 11 is arranged outside the storage shelf 3.

As is clear from Fig. 3, the mold making area 10 has a two-story construction, where, as shown in Fig. 1, arranged in the lower floor portion of the construction are: an empty metal flask storage area 12; a main mold making area 13; a core setting area 14; and, a mold matching area 15. Arranged in an upper story or floor portion above this lower floor portion of the mold making area 10 are: a core making area 16; and, a main pattern/core pattern making area 17, as shown in Fig. 3.

In the main mold making area 13, a metal flask is put on the main pattern. After that, the sand is rammed into the metal flask to prepare a cope half and a drag half of the main mold. In order to prepare these cope and drag halves of the main mold, there are arranged in the lower floor portion shown in Fig. 1: a plurality of metal flask setting sections 20-22; a plurality of pattern preparation sections 23-26; a sand ramming/mold making section 27; a plurality of hardening sections 28-30 for permitting a self-hardening sand to be hardened; a pattern drawing section 31;

a mold-surface coating section 32; and, a mold drying section 33.

In this main mold making area 13, the main pattern, which is supplied from the main pattern storage portion 5 to the pattern preparation sections 23-26, is transferred to the metal flask setting sections 20-22 by using a truck 35 and like means. In these metal flask setting sections 20-22, the metal flask is set on the main pattern. After that, the main pattern on which the metal flask has been set is transferred to the sand ramming/mold making section 27.

In this sand ramming/mold making section 27, the above-mentioned self-hardening sand, in which a self-hardening resin serving as a binder is mixed with the sand, is uniformly rammed into the metal flask, and then transferred to the hardening sections 28-30 in which the sand is permitted to be hardened in the metal flask. After completion of hardening of the sand in the metal flask, the metal flask is inverted to permit the pattern embedded in the sand to be drawn out of the hardened sand in the pattern drawing section 31. After that, the remaining mold, which is free from the pattern, has its surface coated with a heat resisting facing material in the mold-surface coating section 32. Then, the thus coated mold is transferred to the mold drying section 33 in which the mold is dried, so that the cope half and the drag half of the main mold are prepared.

On the other hand, the main pattern having been inverted and drawn out of the hardened sand is transferred back to the metal flask setting sections 20-22 again. In these sections 20-22, the main pattern thus transferred back is set in the metal flask. The main pattern thus set in the metal flask is then transferred to the sand ramming/mold making section 27 in which the sand is rammed

into the metal flask to form the main mold. Alternatively, without set in the metal flask, the main pattern is returned to the pattern preparation sections 23-26 and stored in the main pattern storage portion 5 of the multi-story warehouse 1.

The core setting area 14 serves as a working area for setting the core in the main mold. In order to carry out this working operation, there are provided in the lower floor portion of the foundry plant: a plurality of core supply stations 35-38, to each of which the core is supplied from the core storage portion 6 of the multi-story warehouse 1; and, a plurality of core setting stations 39-42, in each of which the core is set in the main mold.

On the other hand, the cope half and/or the drag half of the main mold are/is transferred by using the truck 43 from the drying section 33 to the core setting stations 39-42. Set in each of the cope half and the drag half of the main mold in the core setting area 14 is the core supplied to each of the core supply stations 35-38.

As is clear from Fig. 1, the mold matching area 15 is arranged or disposed adjacent to the core setting area 14. Disposed in this mold matching area 15 is an automatic mold assembling machine in which: the cope half of the main mold having been transferred from the core setting stations 39-42 using the truck 43 is coupled with the drag half of the same main mold to prepare a completed main mold. At this time, the transfer pallet for the cope half of the main mold is transferred through a conveyer 62 and then another conveyer 73 to the truck 35. As shown in broken lines of Fig. 1, the conveyer 73 is installed under a lower portion of the storage shelf 2. The transfer pallet for the cope half of the main mold, which pallet is thus transferred to the truck 35, is supplied to

the pattern drawing section 31 again by means of the truck 35.

As shown in Fig. 2, the upper floor portion 44 of the foundry plant occupies a position over the mold making area 10 in the plant layout of the foundry plant. This upper floor portion 44 of the foundry plant is provided with both the core making area 16 and the main pattern/core pattern making area 17. The upper/lower floor portions of the storage shelf 2 and the upper floor portion of the other storage shelf 3, which correspond to these areas 16 and 17 of the upper floor portion 44 of the foundry plant, respectively, serve as a core/core pattern storage portion 45 and a main pattern storage portion 47, respectively.

As described above, all the articles such as the main patterns, core patterns and the cores are stored in these storage portions 45, 47 in a condition in which these articles are mounted on their transfer pallets without fail.

In the core making area 16 shown in Fig. 2, the core pattern mounted on the transfer pallet is retrieved from a core pattern delivery portion 46 (shown in Fig. 2) of the multi-story warehouse 1, and delivered to a core pattern supply section 48. Disposed adjacent to this supply section 48 is a core sand ramming/core mold making section 49 in which the self-hardening sand is rammed. The thus rammed sand is then transferred to a hardening section 50 disposed adjacent to the core sand ramming/core mold making section 49. In the hardening section 50, the rammed self-hardening sand is staying until hardened.

After completion of hardening of the core sand, the core pattern is drawn out in a core pattern drawing section 51. The used core pattern is transferred by means of the stacker crane 4 from a pallet delivery portion 52 of the multi-story warehouse 1 back to a used

core pattern storage portion of the warehouse 1. On the other hand, the core itself is mounted on the empty transfer pallet having been supplied from a transfer pallet delivery portion 53 disposed adjacent to the other delivery portion 2 (see Fig. 2). The core thus mounted on the transfer pallet is then transferred to a facing material application section 54 in which the facing material is applied to the core. After that, the core coated with the facing material is dried in a drying section 55 and then directly supplied to a core delivery portion 56 of the upper floor portion of each of the storage shelves 2, 3, through which the core is stored in the storage shelves 2, 3.

As shown in Fig.1, the casting processing area 11 disposed outside the storage shelf 3 is provided with: a melt pouring line 18 disposed in a downstream side of the mold matching area 15; and, a flask removal area 19. The completed mold is transferred to the completed mold storage portion 7 of the lower floor portion of the storage shelf 3 through a roller 61, stacker crane 4a and like means, so that the completed mold is stored in this completed mold storage portion 7 until called out according to the production instruction.

When a completed mold suitable in material properties for the melt is called for in accordance with a production instruction, a corresponding one of the completed molds is retrieved from the completed mold storage portion 7 of the multi-story warehouse 1 by using a stacker crane 4a and supplied thereby to the melt pouring sections 63-64, where the melt is poured into the mold. The mold after completion of such pouring operation is then stored again in the completed mold storage portion 7 for cooling.

The mold after cooled is transferred to the flask removal area 19, where the mold is disassembled into: a casting (i.e., cast

workpiece); a transfer pallet; a metal flask; and, a molding sand. The metal flask after cleaned is transferred to a flask storage area 12 through conveyers 67-70, and then returned to a predetermined position depending on the type of the pallet by means of an unmanned crane and like handling means. On the other hand, the transfer pallet is returned to the conveyer 69 through the conveyers 67, 68, and then transferred to the inverted pattern drawing section 31 by means of the truck 35 through a conveyer 72 installed in a lower portion of a storage shelf 3.

On the other hand, the casting or cast workpiece is subjected to a shot-blasting operation and like surface treatment operations to have its surface abraded, surface-finished and inspected with the object of completing a final cast product. The thus obtained product is then shipped. As for the molding sand, the sand is reclaimed or reconditioned in a sand reconditioning section 71 and then transferred to both a main-mold mixer and a core mixer. As for return scrap, the scrap is returned to a melting section 65.

In the above embodiments, only the mold making area has a two-story construction. However, it is also possible for only a casting processing area to have a two-story construction. In the latter case, an upper floor portion of the storage shelf 2 is replaced in construction with an upper floor portion of the storage shelf 3. Further, it is also possible for each of these areas to have a two-story construction, which may be adequately arranged in construction in each of these areas.

As described in the above, the working areas, for example such as those adapted for melting the metal, for pouring the melt, for solidifying the melt, for cooling the cast workpiece in the mold, and for disassembling the molding flask, are across the multi-story

warehouse 1 from the mold making area. This arrangement makes it possible to prevent any possible heat dispersion, and further makes it possible to efficiently conduct dust collection, ventilation of heated air and the like.

Finally, the present application claims the Convention Priority based on Japanese Patent Application No. 2003-346654 filed on October 6, 2003, which is herein incorporated by reference.